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An analysis of the power sector performance in Nigeria

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ABSTRACT

Rapid economic growth and sustainable development depends largely on the level of infrastructural development of a nation. This reasonably suggests that a good knowledge of the performance of infrastructural services in an economy is vital and an essential requirement for policy directed at attaining sound and vibrant economic development. Drawing from above, the study analyses the overall performance of the Nigeria power (electricity) sector and presents some policy guidelines for achieving a world standard power market and sustainable development. The study found that the Nigeria power sector is underperforming and there is an urgent need for proper policy towards achieving a quality and continuous well-functioning electricity market in the country. The installed capacity of the power plants in Nigeria currently stands at about 6000 MW with just about 40% of it is generated annually. This greatly constrains the local industries from competing regionally and internationally, and also undermines industrialisation and employment generation in the country.

Contents

1. Introduction

The importance of energy in the economic, social and political development of every nation cannot be overemphasised. Transportation, industrial activities, communication, health, and education are some of the areas where energy cannot be substituted. Improvement in standard of living is manifested in rise in food production, increased industrial output, the provision of efficient transportation and telecommunication, adequate shelter, improved healthcare delivery and other human services; each of these requires increased energy consumption. Thus, future energy requirement is expected to grow with increase in standard of living, industrialisation and other socio-economic factors. However, inadequate supply of energy restricts socio-economic activities, constrains economic growth and adversely affects the quality of life.

Specifically, electricity is an important source of energy. It is required at every facet of human life. Its requirement for basic developmental services includes provision of food, industrial activities; provision of pipe borne water, health care, conducive abode, telecommunications, and quality education among others. It serves as the source of power to the industrial sector for the utilisation of their machines; it plays an important role in lighting, heating and other domestic activities, and also serves as an essential tool for telecommunication industry.

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Table 1
Existing and planned electricity plants in Nigeria, 2005.

Existing plants	Type	Nameplate capacity (MW)	Year commissioned	Existing plants	Type	Nameplate capacity (MW)	Year commissioned
Jebba	Hydro	578.4	1984	Sapele GT	Gas	300	1981
Kainji	Hydro	320	1968	Sapele ST	Gas	720	1978 and 1980
Kainji	Hydro	200	1976	Oji	Coal	300	1956
Kainji	Hydro	240	1978	Egbin	Gas	1320	1985
Shiroro	Hydro	600	1990	AES (Egbin-IPP)	Gas	270	2004
Afam I	Gas	20.6	1963	*Total existing*		*6538.3*	
Afam I	Gas	35	1965				
Afam II	Gas	95.6	1976	*Planned*			
Afam III	Gas	110	1978	Papalanto	Gas	330	2007
Afam IV	Gas	450	1982	Omotosho	Gas	330	2007
Ijora	Gas	6.7	1966	Guregu	Gas	414	2007
Ijora	Gas	60	1978	Alaoji		330	2007
Delta I	Gas	72	1966	IPP (Oil compannies)	Gas	3909	2007–2008
Delta II	Gas	120	1975	IPP (Private, non-oil)	Gas	2584	2007–2008
Delta III	Gas	120	1978				
Delta IV	Gas	600	1990	*Total planned*		*7897*	

Source: Future Demand for Electricity in Nigeria, Ibitoye and Adenikinju [6].

Despite the importance of electricity in an economy, Nigeria has not been able to generate adequate and reliable electricity to meet its demand. Electricity installed capacity as at 2005 stood at 6500 MW of which only 3959 MW was supplied due to the ageing power plants, poor maintenance and lack of funds, NEPA [1]. As a result of the poor infrastructure, load shedding and frequent power interruptions are common experience, and the average per capita electricity annual consumption in 2006 was as low as 109 kWh per person IEA [2]. This poor supply often results in welfare loss due to rise in price of goods which occurs from increasing cost of production. Besides, increase in unemployment due to lay off of workers by some industries which either downsize or transfer their operations to the neighbouring countries because of inadequate electricity supply is also a common experience. ADB [3] reports that electricity was by far the most binding constraint to doing business in Nigeria for more than 80% of the firms surveyed. It accounts for 61% indirect losses of firms, followed by transportation (26%), bribery (11%), theft, robbery and crime (2%).

In a bid to find a lasting solution to the problem, Nigeria has launched several reform programs in her energy market. This reform includes privatisation, liberalisation and fundamental transformation of the overall energy sector, especially the electricity subsector. Specifically, the core aspects of the reform in the power sector entail the unbundling of the National Electric Power Authority (NEPA), creation of Independent Regulatory Commission, and encouragement of competition in the generation and distribution of electricity. As part of this reform, an autonomous regulatory body, Nigerian Electricity Regulatory Commission (NERC), was created in 2005 to supervise, control and maintain a financially stable, strong, prudent and competitive electricity industry. Some of the reasons advanced for this reform include intermittent supply of electricity as a result of inadequacy of the existing plants, heavy reliance on the expensive self generation, low tariff rate as against the production cost, and low level of electrification, among others. However, the most important rationale behind this reform is the attempt to prevent the so-called “energy crisis” in the country. Despite the importance of electricity in an economy and in spite of this reform process however, Nigeria is yet to meet up with the yearning demand for electricity by its populace.

The introduction of electricity reform in 2005 provided a renewed hope for the majority of Nigerian populace on the state of electricity in the country, and increased their expectation about rapid transformation of the economy. Today, however, there is mixed hope about what the future holds as regards the performance of electric service delivery in the country given its current poor performance.

While some of the few existing literature on the Nigeria electricity has either focused on the demand analysis using econometric framework or provided the brief overview of the sector, no study has provided the detailed analysis of the overall performance of the sector especially after the introduction of the ongoing reform. Understanding the overall performance of the sector goes a long way in formulating the right policy for economic development. Since present article not only describes the current development and performance of electricity in Nigeria but also provides some guidelines for policy development, it is an important contribution to existing literature. The study is organised as follows. Section 2 provides some information on electricity generation and distribution in Nigeria. Section 3 describes the status and assesses the performance of electricity sector in the country. The following section analyses the consumption of electricity and economic performance. Section 5 highlights the major challenges of the power sector in Nigeria. Section 6 offers some policy guidelines while the last section gathers conclusion based on the findings of the study.

2. Electricity generation and distribution in Nigeria: some background information

Historically, electricity generation in Nigeria dates back to 1896 when it was first produced in Lagos,[1] fifteen years after its existence in England. Today, the major source of electricity generation in Nigeria is fossil fuels through hydro and gas thermal plants. The Power Holding Company of Nigeria (PHCN)[2] co-existing with Independent Power Producers (IPPs) currently plays the leading role in the electric power sub-sector in Nigeria. Following the introduction of the Electric Power Sector Reform Act in 2005, National Electric Power Authority (NEPA) was transformed into a holding Company (PHCN) which was subsequently unbundled into 18 companies; including 6 generators, 11 distributors and one transmission company.[3] These companies are saddled with the responsibility of carrying out the functions relating to the generation, transmission, trading, distribution and bulk supply as well as resale of electricity in the country.

Despite the existence of electricity in the country for over a century and in spite of this reform however, its development has been at a slow rate. The national electricity grid comprises three (3)

[1] Lagos is the former capital of Nigeria.
[2] PHCN is a government agency.
[3] However, till today, these companies are yet to start their operation fully in the country.



Source: Global Energy Network Institute

Fig. 1. National electricity transmission grid of Nigeria.
Source: Global Energy Network Institute http://www.geni.org/globalenergy/library/national_energy_grid/nigeria/index.shtml.

hydro and six (6) thermal generating stations with a total nameplate capacity of about 6000 MW, of which just between 2000 and 3000 MW of it is generated, presidency [4]. Similarly, Sambo [5] reports that just about 40% of the total installed capacity of 6000 MW is available. The reasons that can be ascribed to this drastic fall include high energy loss due to the physical deterioration of the Transmission and Distribution facilities; poor maintenance culture; inadequate supply of fossil fuels; vandalism of equipment; and the remoteness of most of the generating plants from the load centres (Table 1).

Basically, Nigeria generates its electricity through hydro and gas thermal plants[4] and is distributed to the final consumers through a power transmission network which connects the power plants to multiple substations near a populated area. Usually, transmission lines use three phases, namely alternating current (AC), single-phase AC current, and high-voltage direct current systems. Electricity is transmitted at high voltages (110 kV or above) to reduce the energy lost in transmission. Power is usually transmitted as alternating current through overhead power lines while underground power transmission system is used sparingly in some cities in the country (Fig. 1).[5]

3. The status of the Nigeria electricity sector

3.1. Electricity supply

It is very unfortunate that the gap between electricity development of England and Nigeria is far more than the difference between the years of establishment in the two countries. The introduction of electricity in England is just fifteen years ahead of Nigeria, but today what is witnessed in the state of electricity developments in the two nations seems to be hundred years

[4] A close look at Table 1 confirms this statement.

[5] These include Abuja, Lagos, Kano, etc.

Table 2
Electricity generation in the Nigeria's power stations.

Station	Energy source	Year inaugurated	Installed capacity (in MW)	Current output (in MW)	No of units	Output as % of installed capacity
Oji	Thermal	1956	30	NA	4	NA
Delta	Thermal	1966–99	900	366	20	40.67
Kainji	Hydro	1968–78	760	445	12	58.55
Ijora	Thermal	1978	60	8	3	13.33
Sapele	Thermal	1978–1981	1020	62	10	6.08
Afam	Thermal	1978–1982	960	85	18	8.85
Jebba	Hydro	1983–1984	560	339	6	60.54
Egbin	Thermal	1985–1987	1320	243	6	18.41
Shiroro	Hydro	1989–1990	600	281	6	46.83
Total			6210	1829	85	29.45

Source: Bello-Imam [8].

apart. This situation is further regretted when compared electricity development in Nigeria with Turkish electricity performance, where electricity was first generated after seven years of existence in Nigeria.[6] Despite the government's claims of huge investment in the sector, lack of network access and constant power outage has been a common experience by the Nigerian populace. At present, just 10% of rural households and 40% of the country's entire population have access to electricity.[7] Despite this small number of network access, the generation and supply have still not been matched with demand even among the electrolysed households. In 2001 for instance, generation fell below the installed capacity of about 5600 MW to an average of about 1750 MW, creating a supply shortage of 3250 MW.[8] Also, only nineteen of the twenty-nine installed generating plants are in operation Sambo [7] and this low generation and supply usually constrains the consumption to what is available.

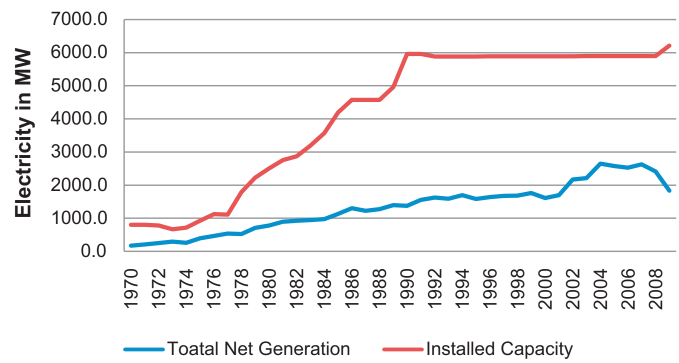


Fig. 2. Electricity generation in Nigeria, 1970–2009.

3.1.1. Capacity utilisation

Table 2 shows the levels of installed capacity and electricity generation of the various generating plants in Nigeria. The total installed capacity stood at 6210 MW with the highest installed capacity and output coming from Egbin thermal and Kainji hydro plants respectively. Jebba hydro plants have the highest utilisation rate followed by Kainji while the Sapele thermal plants have the lowest utilisation rate in the country. Overall, the hydro plants in the country have higher utilisation rate than thermal plants. This may not be unconnected with low level of technology or technical know-how and or inadequate supply of primary energy (gas) to the thermal stations, due to high level of gas flaring in the country.[9] In spite of this high rate of capacity utilisation from the hydro stations, the overall utilisation rate is generally low and this often results in shortage of supply which substantially weakens the industrialisation process, and significantly undermines the efforts to achieve sustained economic growth, increased competitiveness of domestic industries in regional and global markets, and employment generation.

Fig. 2 and Table 3 present the historical installed capacity and electricity generation in Nigeria over the period of 1970–2009. A close look at the figure and the table shows that the Nigeria's electricity industry is operating far below its installed capacity and the optimal level of production. This reflects the extent of inefficiency in the sector. For instance, the average load factor in the Nigeria electricity industry between 1970 and 2009 stood at approximately 33%. This simply means that capacity is only used for approximately 8 h a day over this period. As a result of the higher unit cost which resulted from this low load factor, government often spends heavily in subsidising the price of electricity in order to make it affordable for the citizens. In 2006 for instance, government spent over US$2.79 million in subsidising electricity price in the country. This high unit cost usually affects the ability of the electricity producer to sell at a high spark spread, and subsidising it sometimes affects other developmental projects that would have been implemented by the government. Therefore, government as well as all other stakeholders should try and rise up to the challenges in order to find lasting solution to the problem. This will further ameliorate the problem of inadequate supply that characterises the country's electricity market.

3.1.2. Overall electricity loss

The operational performance of the power sector can also be improved by diminishing the high system losses. The difference between electricity generated and electricity billed has been high in the Nigerian electricity industry. The system loss ratio rose from 30.5% in 1980 to a peak of 46.9% in 1996. Over since then, the loss ratio has been fluctuating and stood at 9.4% in 2008. Even though the current level of loss ratio in Nigeria is within the economic loss ratio of between 7% and 10% reported by Schramm [12], it can still be argued that there exists major scope for loss reduction in the Nigerian electricity industry. Besides the poor conditions of the Transmission and Distribution network (T&D), parts of these losses are due to non-technical factors such as inaccurate metering and billing, un-metered supplies, non-payments and illegal connections. Efforts should therefore be made to minimize these losses by adopting some strategies to combat these non-technical factors as well as improvements in Transmission and Distribution facilities in the country. This will go a long way in improving the capacity of the sector in meeting the energy needs of the country (Table 4).

[6] Generation of electricity started in Turkey in 1902, with a 2 kW hydropower in Tarsus. Turkish electricity installed capacity and generation had reached 41.82 million kW and 188.84 billion kWh respectively in 2008.

[7] This does not suggest that these households have access to uninterrupted supply.

[8] The actual electricity demand in 2001 was 5000 MW.

[9] Nigeria is currently the second largest natural gas flaring in the world.

Table 3
Historical electricity generation and capacity utilisation in Nigeria, 1970–2009.

Year	Installed capacity in MW	Total net generation in MW	Load factor[a]	Year	Installed capacity in MW	Total net generation in MW	Load factor[a]
1970	804.7	176.6	21.9	1990	5958	1373.2	23.0
1971	804.7	215.4	26.8	1991	5959	1554.0	26.1
1972	786.7	255.4	32.5	1992	5881	1626.4	27.7
1973	670.6	299.7	44.7	1993	5881	1588.2	27.0
1974	721	261.1	36.2	1994	5881	1698.3	28.9
1975	926.2	395.4	42.7	1995	5881	1585.5	27.0
1976	1125.2	468.7	41.7	1996	5888	1640.1	27.9
1977	1114.2	538.0	48.3	1997	5888	1677.7	28.5
1978	1793.7	522.7	29.1	1998	5888	1681.5	28.6
1979	2230.6	710.7	31.9	1999	5888	1761.6	29.9
1980	2507	783.9	31.3	2000	5888	1613.1	27.4
1981	2755	895.0	32.5	2001	5888	1693.7	28.8
1982	2872	929.2	32.4	2002	5888	2163.6	36.7
1983	3192	945.5	29.6	2003	5898	2209.1	37.5
1984	3572	978.7	27.4	2004	5898	2645.0	44.8
1985	4192	1133.4	27.0	2005	5898	2571.2	43.6
1986	4574	1300.9	28.4	2006	5898	2523.9	42.8
1987	4574	1227.5	26.8	2007	5898	2623.1	44.5
1988	4574	1273.4	27.8	2008	5898	2409.8	40.9
1989	4960	1398.5	28.2	2009	6210	1829	29.5

Source: CBN Statistical Bulletin [9], EIA [10] and IEA [11].
[a] Author's computation.

3.1.3. Energy conservation

Another important issue in the world today is energy conservation strategy given its importance in combating global warming challenges. In electricity generation, the primary mechanism to improve fuel consumption can be inter-fuel substitution. Table 5 examines the substitution possibilities among different forms of energy (fuel oil, coal, hydro and natural gas) in Nigeria. In the 1980s, some significant modifications were made in the type of fuel consumed by the Nigeria's power plants. Since this period, the share of natural gas in electricity generation in the country has increased tremendously. For instance, the share of natural gas's output rose from 5.9% in 1970 to 43.6% in 1980 and currently constitutes about 67% of the total electricity generation in the country. The increasing share of natural gas in thermal power plants reflects the growing awareness of natural gas availability and its advantages for generating electricity. Nigeria has about 188 trillion cubic feet (Tcf) of natural gas and this represents the seventh largest endowment in the world. Substituting natural gas in power generation, in addition

Table 4
Distribution losses in the Nigeria electricity industry, 1980–2009.

Year	Installed capacity in MW	Total net generation in MW	Load factor	Distribution loss in MW	Loss ratio[a]
1980	2507	783.9	31.3	239.0	30.5
1981	2755	895.0	32.5	234.0	26.1
1982	2872	929.2	32.4	236.5	25.5
1983	3192	945.5	29.6	239.0	25.3
1984	3572	978.7	27.4	273.3	27.9
1985	4192	1133.4	27.0	383.3	33.8
1986	4574	1300.9	28.4	339.2	26.1
1987	4574	1227.5	26.8	388.4	31.6
1988	4574	1273.4	27.8	431.2	33.9
1989	4960	1398.5	28.2	434.5	31.1
1990	5958	1373.2	23.0	445.4	32.4
1991	5959	1554.0	26.1	607.8	39.1
1992	5881	1626.4	27.7	653.2	40.2
1993	5881	1588.2	27.0	632.4	39.8
1994	5881	1698.3	28.9	774.1	45.6
1995	5881	1585.5	27.0	682.8	43.1
1996	5888	1640.1	27.9	768.9	46.9
1997	5888	1677.7	28.5	777.7	46.4
1998	5888	1681.5	28.6	702.9	41.8
1999	5888	1761.6	29.9	805.1	45.7
2000	5888	1613.1	27.4	641.3	39.8
2001	5888	1693.7	28.8	683.4	40.4
2002	5888	2163.6	36.7	726.4	33.6
2003	5898	2209.1	37.5	769.3	34.8
2004	5898	2645.0	44.8	861.3	32.6
2005	5898	2571.2	43.6	637.0	24.8
2006	5898	2523.9	42.8	819.7	32.5
2007	5898	2623.1	44.5	302.5	11.5
2008	5898	2409.8	40.9	227.1	9.4
2009	6210	1829	29.5	NA	

Source: EIA [10]; IEA [11].
[a] Author's computation.

Table 5
Electricity generation in Nigeria by fuel types, 1971–2007.

Year	Production in (MW)	Natural gas in (MWh)	% of total	Oil in (MWh)	% of total	Coal in (MWh)	% of total	Hydro in (MWh)	% of total
1971	215.4	112,000.0	5.9	201,000.0	10.7	0.0	0.0	1,574,000.0	83.4
1972	255.4	247,000.0	11.0	542,000.0	24.2	1000.0	0.0	1,447,000.0	64.7
1973	299.7	303,000.0	11.5	464,000.0	17.7	0.0	0.0	1,858,000.0	70.8
1974	261.1	150,000.0	6.6	96,000.0	4.2	52,000.0	2.3	1,989,000.0	87.0
1975	395.4	545,000.0	15.7	475,000.0	13.7	51,000.0	1.5	2,393,000.0	69.1
1976	468.7	768,000.0	18.7	376,000.0	9.2	55,000.0	1.3	2,907,000.0	70.8
1977	538.0	1,015,000.0	21.5	754,000.0	16.0	55,000.0	1.2	2,889,000.0	61.3
1978	522.7	1,349,000.0	29.5	906,000.0	19.8	0.0	0.0	2,324,000.0	50.8
1979	716.7	2,140,000.0	34.1	833,000.0	13.3	0.0	0.0	3,305,000.0	52.6
1980	819.5	3,128,000.0	43.6	1,268,000.0	17.7	0.0	0.0	2,783,000.0	38.8
1981	887.7	4,138,000.0	53.2	1,248,000.0	16.0	0.0	0.0	2,390,000.0	30.7
1982	974.0	4,418,000.0	51.8	1,641,000.0	19.2	0.0	0.0	2,473,000.0	29.0
1983	994.6	5,491,000.0	63.0	1,229,000.0	14.1	4000.0	0.0	1,989,000.0	22.8
1984	1025.6	4,843,000.0	53.9	1,466,000.0	16.3	7000.0	0.1	2,668,000.0	29.7
1985	1166.8	5,258,000.0	51.4	1,868,000.0	18.3	4000.0	0.0	3,091,000.0	30.2
1986	1229.0	4,718,000.0	43.8	2,412,000.0	22.4	6000.0	0.1	3,630,000.0	33.7
1987	1286.0	5,735,000.0	50.9	2,240,000.0	19.9	6000.0	0.1	3,284,000.0	29.2
1988	1330.4	5,395,000.0	46.3	2,240,000.0	19.2	11,000.0	0.1	4,008,000.0	34.4
1989	1462.7	6,422,000.0	50.1	2,240,000.0	17.5	11,000.0	0.1	4,140,000.0	32.3
1990	1536.9	7,223,000.0	53.7	1,840,000.0	13.7	13,000.0	0.1	4,387,000.0	32.6
1991	1617.2	6,578,000.0	46.4	1,645,000.0	11.6	13,000.0	0.1	5,931,000.0	41.9
1992	1693.4	6,628,000.0	44.7	2,133,000.0	14.4	14,000.0	0.1	6,059,000.0	40.8
1993	1655.8	6,979,000.0	48.1	1,954,000.0	13.5	0.0	0.0	5,572,000.0	38.4
1994	1772.9	8,351,000.0	53.8	1,618,000.0	10.4	0.0	0.0	5,562,000.0	35.8
1995	1810.2	8,982,000.0	56.6	1,375,000.0	8.7	0.0	0.0	5,500,000.0	34.7
1996	1854.2	9,013,000.0	55.5	1,730,000.0	10.7	0.0	0.0	5,500,000.0	33.9
1997	1839.8	8,774,000.0	54.4	1,750,000.0	10.9	0.0	0.0	5,593,000.0	34.7
1998	1724.9	8,121,000.0	53.7	1,096,000.0	7.3	0.0	0.0	5,893,000.0	39.0
1999	1836.6	8,548,000.0	53.1	1,267,000.0	7.9	0.0	0.0	6,274,000.0	39.0
2000	1681.2	7,962,000.0	54.1	1,022,000.0	6.9	0.0	0.0	5,743,000.0	39.0
2001	1765.2	8,548,000.0	55.3	886,000.0	5.7	0.0	0.0	6,029,000.0	39.0
2002	2250.7	8,754,000.0	44.4	2,561,000.0	13.0	0.0	0.0	8,401,000.0	42.6
2003	2304.0	11,713,000.0	58.0	865,000.0	4.3	0.0	0.0	7,605,000.0	37.7
2004	2763.6	12,677,000.0	52.4	3,257,000.0	13.5	0.0	0.0	8,275,000.0	34.2
2005	2687.1	13,489,000.0	57.3	2,099,000.0	8.9	0.0	0.0	7,951,000.0	33.8
2006	2638.1	13,361,000.0	57.8	2,035,000.0	8.8	0.0	0.0	7,714,000.0	33.4
2007	2623.1	15,435,000.0	67.2	1,137,000.0	4.9	0.0	0.0	6,406,000.0	27.9

Source: World Development Indicators [13].

to environmental considerations, allows the use of fuel oil for other purposes.[10] The reduction in hydro consumption in the country's power plants is also advisable given its seasonal variability.[11]

3.2. Electricity demand

The consumption of electricity in Nigeria has centred around three major sectors namely, industrial, residential, and commercial and public services. From Table 6, the proportion of electricity used for industrial purposes has decreased significantly while residential consumption has risen substantially. Industrial electricity consumption declined from 62.9% to just 9.7% in 2005 and currently stands at 20%. Similarly, residential consumption rose from 37.1% to 63.8% between 1970 and 2005 and currently accounts for 55.3% of total electricity consumption in the country. This low industrial consumption is easily explained by the intermittent power supply that has forced many small industries out of operation and many of the big industries to rely heavily on their privately owned diesel generator using less power from the national grid. Similarly, the rise in domestic consumption can be ascribed to significant population increase that has put upward pressure on residential demand over this period.

[10] Natural gas is the cleanest of fossil fuels. The use of natural gas for electricity generation in Nigeria will reduce gas flaring in the country.

[11] There is always reduction of water level in the Nigeria's hydro plants during the dry season and this usually poses serious challenges to electricity generation and supply in the country.

4. Electricity consumption and the Nigeria economic performance

Despite the importance of infrastructural services to economic development, the consumption of electricity in Nigeria has been very low due to inadequate supply. This possibly might have been responsible for the slow rate of development in the country. Electricity consumption in the country stood at just 137 kWh per head in 2007. At 137 kWh per capita, electricity consumption is one of the lowest in the world (Table 7).

The most regrettable situation is that electricity sector has never contributed up to 2% and 1% to the economic value added and economic development respectively in the country. Currently, Nigeria electricity contributes only 0.32% and 0.22% to economic value added and economic growth respectively. This possibly reflects the poor state of infrastructural developments in the country and the reason why Nigeria is ranked among the top poor economies in the world despite its abundant natural endowment (Table 8).

5. Challenges facing the Nigeria electricity sector

Poor maintenance and management: One of the greatest challenges facing electricity distribution in Nigeria is high rate of transformer breakdown. One of the basic causes of this is lack of information at the base station on the loading and current status of the 11 kV/415 V transformer and associated feeders in the country. Due to inadequate monitoring, occurrence of overloading which usually leads to low voltage at customer end always pose high risk

Table 6
Electricity consumption in Nigeria in MW per hour.

Year	Total	Industrial	% of total	Residential	% of total	Commercial and public services	% of total
1970	14.3	91.4	62.9	53.9	37.1	NA	NA
1971	181.1	114.9	63.5	66.2	36.5	NA	NA
1972	211.1	138.2	65.5	72.9	34.5	NA	NA
1973	232.7	146.1	62.8	86.6	37.2	NA	NA
1974	266.2	163.2	61.3	103	38.7	NA	NA
1975	318.7	200.4	62.9	118.3	37.1	NA	NA
1976	369.8	214.6	58	155.2	42	NA	NA
1977	435.7	253	58.1	182.7	41.9	NA	NA
1978	504.4	157.7	31.3	253.2	77.9	93.5	18.5
1979	460.1	160.3	34.8	221.9	48.2	77.9	16.9
1980	536.9	199.7	37.2	243.1	45.3	94.1	17.5
1981	335.9	121	30.2	193.6	48.4	21.3	21.3
1982	685.6	262	38.4	344.5	50.6	79.1	11.6
1983	696.7	254.4	36.5	358	51.4	84.3	12.1
1984	625.5	217.2	34.7	326.6	52.2	81.7	13.1
1985	717.4	259.8	36.2	372	51.9	85.6	11.9
1986	841.8	280.5	33.3	476.6	56.6	84.7	10.1
1987	852.9	294.1	34.5	468.6	54.9	90.2	10.6
1988	853.5	291.1	34.1	443.8	52	118.6	13.9
1989	976.8	257.9	26.4	523.6	53.6	195.3	20
1990	888.5	230.1	25.6	450.8	50.2	217.6	24.2
1991	946.6	253.7	26.8	459.3	48.5	254.1	26.8
1992	993	245.3	24.7	481.6	48.5	266.1	26.8
1993	1141.4	237.4	20.8	592.4	51.9	311.6	27.3
1994	1115	233.3	21.3	575	52.5	306.7	28
1995	1050.9	218.7	20.3	552.6	51.3	279.6	26
1996	1033.3	235.3	22.8	518	50.1	280	27.1
1997	1009.6	236.8	23.5	508.3	50.3	264.5	26.2
1998	972.8	218.9	22.5	500	51.4	253.9	26.1
1999	883.7	191.8	21.7	455.1	51.5	236.8	26.8
2000	1017.3	223.8	22	518.8	51	274.7	27
2001	1104.7	241.9	21.9	564.5	51.1	298.3	27
2002	1271.6	146.2	11.5	752.8	59.2	372.6	29.3
2003	1519.5	196	12.9	905.6	59.6	417.9	27.5
2004	1825.8	398	21.8	938.5	51.4	489.3	26.8
2005	1873.1	182.3	9.7	1194.3	63.8	496.6	26.5
2006	1742.94	383.45	22.0	894.07	51.3	465.41	26.7
2007	2245.57	494.07	22.0	1151.95	51.3	599.55	26.7
2008	2113.83	422.72	20.0	1168.96	55.3	522.15	24.7

Source: CBN [9]; IEA [11].

Table 7
Electricity consumption per capita in selected countries in 2006.

Country	Electricity consumption (in kWh)	Rank	Country	Electricity consumption (in kWh)	Rank
Iceland	31,147.29	1	Algeria	806.95	118
Norway	24,011.23	2	Ghana	300.01	142
Canada	16,279.41	4	Cameroon	199.19	145
Sweden	14,769.40	7	Angola	188.15	146
UK	5,773.62	36	Coted'Ivoire	172.03	149
Libya	3,471.80	62	Kenya	145.80	153
Turkey	1,940.27	84	Congo	137.33	153
Namibia	1,557.43	96	Nigeria	109.50	156
Egypt	1,275.91	103	Togo	96.32	158
Tunisia	1,060.97	109	Congo DR	86.93	164
Zimbabwe	885.97	115	Total number of countries ranked		189

Source: Nation Master [14].

to the distribution equipment and results in frequent breakdown of transformers and feeders in the country. Similarly, the absence of switches at different points in the distribution network makes it impossible to isolate certain loads for load shedding when necessary. The only available option in the country's present distribution network is the circuit breaker at substations. However, the use of this circuit breaker for load management is not desirable because it disconnects the power supply to a large portion of customers.[12]

[12] Circuit breakers are only produced as a means of protection to completely isolate the downstream network in the occurrence of fault in the system.

Vandalism of equipments: This constitutes another serious problem to the Nigeria electricity delivery. Some unknown criminals have continuously engaged themselves in sabotaging government's efforts in electricity building by stealing power equipments such as poles, cables as well as vandalising the pipes that connects fuel sources to the power plants. In fact, frequent vandalism of the gas supply infrastructure, mostly due to socio-political unrest in the Niger-Delta, has been a major cause of power supply interruptions in the country, ADB [3].

Poor energy investments and lack of competition: Inadequate funding for investment in new power stations and maintenance of existing ones as well as a limited gas processing and supply

Table 8
Key performance indicators of Nigeria electricity.

Year	Electricity consumption (kWh per capita)	GDP per capita, PPP (constant 2005 international $)	GDP, PPP (constant 2005 international $) per kWh	Value added in million ₦			% electricity contribution to GDP
				Electricity	Total	Electricity as % of total	
1971	28.32						
1972	32.45						
1973	35.00						
1974	32.57						
1975	45.36						
1976	51.07						
1977	58.53						
1978	59.94						
1979	59.01						
1980	67.05	1667.93	24.87				
1981	50.10	1408.88	28.12	768.62	51,731.79	1.49	0.63
1982	80.54	1368.38	16.99	820.81	53,658.95	1.53	0.66
1983	80.33	1262.57	15.72	784.41	57,963.31	1.35	0.58
1984	60.95	1170.89	19.21	768.62	64,326.34	1.19	0.51
1985	78.95	1251.11	15.85	850.6	73,542.02	1.16	0.49
1986	89.13	1248.67	14.01	639.8	74,908.22	0.85	0.36
1987	87.51	1206.92	13.79	669.23	111,912.93	0.60	0.25
1988	85.33	1291.07	15.13	674.57	147,941.13	0.46	0.19
1989	95.00	1347.53	14.18	1933.47	228,451.46	0.85	0.35
1990	85.18	1420.14	16.67	2107.94	281,550.27	0.75	0.31
1991	87.61	1449.72	16.55	2316.61	329,070.75	0.70	0.29
1992	88.03	1454.48	16.52	2417.38	555,445.51	0.44	0.18
1993	98.60	1449.49	14.70	2526.58	715,241.87	0.35	0.15
1994	93.39	1415.13	15.15	2913.03	945,557.02	0.31	0.13
1995	89.42	1414.91	15.82	3034.93	2,008,564.01	0.15	0.06
1996	83.98	1439.74	17.14	3157.21	2,799,036.11	0.11	0.05
1997	80.19	1442.74	17.99	3148.22	2,906,624.88	0.11	0.04
1998	75.30	1434.35	19.05	3021.86	2,816,406.01	0.11	0.04
1999	74.17	1415.17	19.08	3126.63	3,312,240.87	0.09	0.04
2000	72.96	1455.67	19.95	3,232.59	4,717,332.11	0.07	0.03
2001	74.08	1464.71	19.77	43,265.23	4,909,526.481	0.88	0.33
2002	101.88	1451.73	14.25	49,815.57	7,128,203.1	0.70	0.26
2003	99.72	1562.99	15.67	59,530.98	8,742,646.646	0.68	0.25
2004	120.82	1687.52	13.97	71,530.75	11,586,241.89	0.62	0.22
2005	127.02	1736.55	13.67	78,177.81	14,735,323.93	0.53	0.19
2006	109.97	1800.82	16.38	59,493.00	18,709,786.48	0.32	0.22
2007	137.19	1872.22	13.65				

Source: World Bank [13]; NBS [15].

infrastructure constitute another constraint facing the Nigeria electricity industry. While government has been trying to finance the sector for better performance, there is limited access for the private investors or private participation to enter the energy sector, especially electricity, in Nigeria. As at 2008, foreign private investment in electrical machinery stood at just 1.89% of the total foreign private investment in manufacturing and processing sector. This limits the existence of competition in the market and allows high rate of system failure. In addition, inability of the customers to switch over their suppliers is another problem of low private access in the Nigeria electricity market. Since consumers are restricted to only one supplier (PHCN), there is no switch over advantage for them and as a result, the supplier is not at pressure to improve on its inefficiency.

Corruption: Corruption is a disease that has eaten deep in the bone marrow of many Nigerians, especially in the public sector. Despite the government claimed huge spending on power, the Nigeria electricity sector is performing below expectation because more often than not the claimed investments do not get down to the intended projects. Therefore, while these projects have been recorded implemented, it remains unexecuted in reality and remains ageing and obsolete. This account for the reason why many power projects in the country are either abandoned or completely unexecuted after announcement might have been made for their execution.

6. Guidelines for policy makers

The overall objective of energy-related policies should be ensuring quality, sufficient, reliable, and affordable energy supplies towards achieving sustainable socio-economic development, while protecting the environment. Given the necessity of good and effective energy policy in the Nigeria electricity market, the following guidelines are therefore proposed for the policy makers to improve and strengthen the industry for the purpose of achieving sustainable economic development:

- On-going reform which anchors restructuring of both the petroleum and power industries should be strengthened to create access for more investors to enter the industry. This will create a more competitive energy market anchored on market-responsive energy pricing, and therefore results in a more efficient system that guarantees improvements in the level of welfare.
- Complete elimination or minimization of concerns about security of supply of gas associated with resource control agitation in the Niger Delta region is urgently needed. Credible and decisive effort to eliminate tension at the core has now become more necessary than ever before.
- Proper efficient and effective project monitoring committee should be set up to monitor the progress of government investments in the sector. This will to a reasonable extent prevent the

Table A1
Consolidated Nigerian energy balance 2007.

Source	Energy supplied basis: thousand tonnes of oil equivalent Primary fuel availability							
	Coal and manufactured fuels	Oil and petroleum products	Natural gas	Hydro	Renewable andwaste	Electricity	Heat	Total
1 Indigenous production	4.93	114,850.66	26,540.15	535.52	88,309.41	0.00	0.00	230,240.7
2 Imports	0.00	7877.13	0.00	0.00	0.00	0.00	0.00	7877.126
3 Exports	0.00	−114,543.47	−17,743.80	0.00	0.00	0.00	0.00	−132,287
4 Marine bunkers	0.00	−1070.05	0.00	0.00	0.00	0.00	0.00	−1070.05
5 Stock changes	0.00	560.74	0.00	0.00	0.00	0.00	0.00	560.744
6 Primary energy supply	4.93	7675.01	8796.35	535.52	88,309.41	0.00	0.00	105,321.2
7 Statistical differences	0.00	2466.56	329.08	0.00	−0.05	0.00	0.00	2795.591
8 Primary demand	4.93	10,141.57	9125.43	535.52	88,309.36	0.00	0.00	108,116.8
9 Transfers &Transformation	0.00	−1450.87	−2615.14	−535.52	−2347.05	1976.11	0.00	−4972.47
10 Energy industry use	0.00	−249.04	−4118.95	0.00	0.00	−56.50	0.00	−4424.48
11 Distribution losses	0.00	−28.72	−910.90	0.00	0.00	−227.90	0.00	−1167.52
12 Final consumption	4.93	8412.95	1480.45	0.00	85,962.31	1691.71	0.00	97,552.34
13 Non-energy use	0.00	122.60	0.00	0.00	0.00	0.00		122.599
14 Final energy consumption	4.93	8290.35	1480.45	0.00	85,962.31	1691.71	0.00	97,429.74
14a Industry	4.93	156.37	1480.45	0.00	8700.56	372.21	0.00	10,714.51
14b Transport	0.00	7697.49	0.00	0.00	0.00	0.00	0.00	7697.488
14c Domestic	0.00	436.49	0.00	0.00	77,261.76	867.83	0.00	78,566.07
14d Commercial & public services	0.00	0.00	0.00	0.00	0.00	451.67	0.00	451.672
Electricity output in GWh	0.00	4919.00	11,832.00	6227.00	0.00	0.00	0.00	22,978
Elect output-main act. producer electricity plants	0.00	4919.00	11,832.00	6100.00	0.00	0.00	0.00	22,851
Electricity output-autoproducer electricity plants	0.00	0.00	0.00	127.00	0.00	0.00	0.00	127

Source: World Energy Balances of Countries (Edition: 2010).
Definitions: Line 1: *Indigenous production* refers to extraction of primary fuels and the generation of primary energy such as hydro, fuel oil, natural gas, and wind; lines 2 and 3: *Imports and exports* are energy moving into or out of Nigeria (exports are shown with negative sign); line 4: *Marine bunkers* are fuels consumed by ships during the voyage to other countries; thus like exports they have a negative sign; line 5: *Stock changes* are addition to or withdrawals from stocks held by producers and the transformation industries; line 8: *Primary demand* is the actual demand recorded for primary fuels; line 7: *Statistical difference* is the recorded error between primary demand (line 8) and primary supply (line 6). It is negative if supply is greater than demand and positive otherwise; line 9: *Transfer and transformation* refers to the processes and activities that transform the original or initial primary energy into another form better than the original form; line 10: *Energy industry use* refers to the consumption of energy by both the extraction and the transformation activities; line 11: *Distribution losses* consist of the intrinsic losses that occur during the transmission, distribution and transportation of electricity, gas and heat; line 12: *Final consumption* covers both Non-energy use (line 13) such as lubricants and bitumen for roads; and final energy consumption (line 14) which are consumption of energy by industry, transport, domestic and other final users (e.g. university, hospital, etc.).

prevailing cases of projects abandonment that characterised the sector, due to high level of corruption in the system.

- Government should invest on research and development to make the Nigeria electricity sector cope with the current trends of technological advancement in the sector all over the world. This will reduce or completely solve the problem of low generation and high distribution losses that usually results from technical problem.
- There is need for more integration between the Nigeria electricity sector and the oil companies (IOCs) in the country. This will strengthen the market linkages between the duos such that the associated gas generated by the companies will be demanded more locally to generate electricity rather than flaring it. This, apart from its impacts in increasing electricity generation and supply, will reduce the level of gas flaring and its associated environmental consequences in the country.
- The need for high level of security to curb the vandalism of electricity distribution equipments in the country is inevitable. Electricity equipments security committee or foundation should be instituted to oversee any case of electricity generation and distribution equipments vandalism and prosecute the culprits accordingly.
- More attention should be paid to the renewable energy availability in the country. Nigeria is blessed with abundant renewable including wind, solar and biomass among others. These renewable are yet to be fully harnessed to generate electricity in the country. Harnessing them, apart from increasing electricity potentials in the country, will equally reduce the environmental pressure posed by combustion of fossil fuels.

7. Conclusion

It is fairly settled in the literature that substantial expansion in quantity, quality and access to adequate and reliable energy infrastructural services are essential to rapid expanded and sustained economic growth, employment generation, poverty reduction and overall well-being of an economy. An analysis of performance of the Nigeria electricity industry conducted in this study provides a basis for investigating and understanding the effectiveness of the sector in discharging its duties. The persistent suboptimal operating levels of electricity infrastructure capacity and poor service delivery in the country over the period of analysis, from both growth and welfare maximization perspectives, raises the fundamental question: what ought to be done to establish and maintain a sustained and robust electricity market of international standards characterised by continuous service reliability, accessibility and availability that ensures and supports sustainable human development in Nigeria. Given that overcoming the energy crises and ensuring efficient functioning energy market of international standards in quantity, access, quality and reliability of services in Nigeria is significant towards achieving the Nigeria's ‘Vision 2020’, there is a need for radical reform process that prioritises citizens' welfare in the system.[13]

Appendix A.

See Table A1.

[13] Vision 2020 is the desire of the government that Nigeria be one of the top 20 economies in the world by 2020.

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